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FLOW AND SEDIMENT TRANSPORT INDUCED BY PLUNGING WAVES

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INTRODUCTION

Most of the previously mentioned laboratory studies focusing on surf and/or swash zone processes were conducted on either rigid or live sediment beds. An exception is the recent work of Sumer et al. (2011), who exploited a dual-use strategy, utilizing both rigid (smooth) and live sediment beds subjected to plunging solitary waves. This approach enabled detailed velocity and (hot film) bed shear stress measurements taken on a rigid bed profiles to be directly related to near-bed pore-pressure measurements and subsequent morphological evolution observed on live sediment beds, under the same initial bed profile and wave conditions. The present work extends this methodology, making dual-use of fixed and live sediment beds for the study of wave breaking, sediment transport, and morphological processes induced by regular (periodic) waves plunging near the shoreline.

EXPERIMENTS

Two parallel experiments were conducted: (1) a rigid-bed experiment, allowing direct (hot film) measurements of bed shear stresses; and (2) a sediment-bed experiment, allowing for the measurement of pore-water pressures as well as observation of sediment suspension and bed morphological changes. Both experiments utilize the same initial bed profile and wave forcing.

SOME KEY RESULTS

The experiments show that the mean bed shear stresses experienced onshore of incipient breaking are amplified by nearly a factor of 2 relative to pre-breaking conditions, whereas their corresponding turbulent fluctuations are amplified even more strongly, by a factor of 5-6.

The plunging processes lead to a series of vortices, whose formation may be explained as the result of shear layer instability. Measurements show that these vortices can significantly enhance peaks in the offshore-directed bed shear stresses. Moreover, near-bed pore pressure measurements in the sediment bed indicate that these vortices cause large upward-directed pressure gradients, which in turn produce a corresponding series of suspended sediment plumes shoreward of the initial breaking event. Fig. 1 illustrates a sequence of pictures illustrating the sediment plume caused by the primary vortex generated immediately after the breaking.

These findings are related to the induced morphological changes over both short and long time scales. The present results are also compared and contrasted with previous experiments utilizing a similar methodology, but involving plunging solitary waves (Sumer et al., 2011).

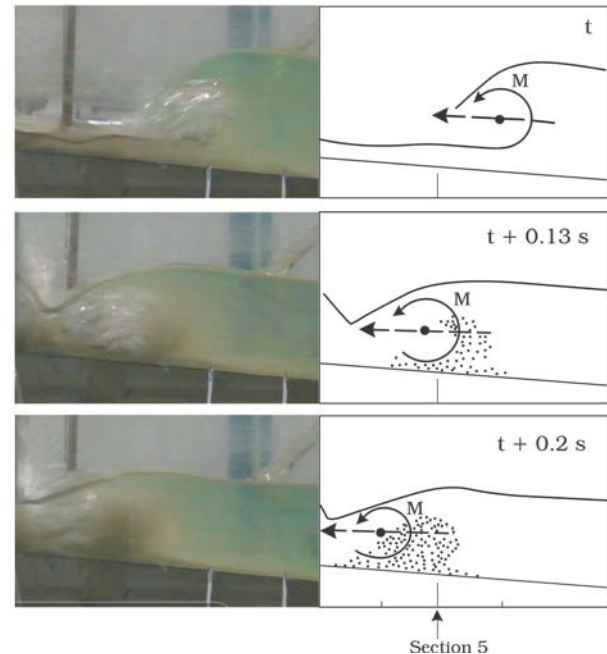


Figure 1 - Sequence of pictures illustrating the suspension of sediment from the bed. The vortex (Vortex M) creates a pressure minimum, as revealed by the present pore-water pressure measurements.

The full results of the present work have been published in Sumer et al. (2013)

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